Wideband Dual Polarizations Feed For Radiometer

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***Abstract*—This paper presents the design and development of a wideband Finline orthomode transducer(OMT) and feeding system used for the radiometer. Finline OMT and filters are employed to separate the dual polarization waves for different frequencies. The wide band loaded corrugated horn is used to cover the almost 2:1 frequency band. Test results shown that the feed horn patterns at three frequencies (18.7GHz, 23.8GHz and 37GHz) remain good shape, while the cross-polarization levels are below -23dB at all working bands. The VSWR are lower than 1.5 at all the three working frequency bands.**

Keywords—wide band, finline, corrugated horn, orthomode transducer,radiometer

I. INTRODUCTION

18.7GHz,23.8GHz and 37GHz are frequencies are sensitive to the atmospheric water vapor, precipitation over oceans, cloud liquid water and snow or ice coverage and other geographical parameters[1].The radiometer system usually need symmetrical beam for both polarizations at all frequencies, in particular, a high beam efficiency is required for the antenna to achieve the necessary contrast for the scene-brightness variation[1].In order to have high beam efficiency, the antennas usually have low side lobe level(SLL), high gain, and good symmetry between the two principal plane far field patterns. However, the radiometer have almost 2:1 working frequencies band, so the dual-polarized multifrequencies common aperture feed is a critical component for the whole antenna system. Usually the common corrugated horn has the bandwidth of 1.6:1[2], in order to broaden the bandwidth of the feed, loaded ring[3]design is used. OMT with maximum-to-minimum frequency ratio of 2:1 is very difficult to design due to the high frequency high-order mode wave in the common waveguide[4].For the sake of meeting the stringent specifications of the very low VSWR, high beam efficiency together with the low cross-polarization levels of the radiometer antenna, the feeding network is chosen as polarization separation firstly using OMT followed by frequency separation filters. The finline OMT[5] is employed to separate the dual-polarization wave, as for the vertical polarization wave, the lowest frequency wave is extracted by the band pass filter(BPF1),the high pass filter(HPF1) and another BPF2 are used to acquire the middle frequency wave, the highest frequency wave can be obtained by the HPF2 in the end of the waveguide.

II. DESIGN OF THE LOADED CORRUGATED HORN

The vswr of the offset dish is affected mostly by the feed horn and network, at the same time, the crosspolarization of the common aperture feed is influenced greatly by the feeding network in addition to the corrugated horn, so the optimization process should take into account the horn, OMT and filters network together. The diagram of the feed horn together with the feeding network is displayed in Fig.1.The three frequency dual polarization waves are received in the corrugated horn. The finline OMT separates the dual polarization wave into two channels, the HPF and DPF are used to gather the wave at different three frequencies.

In order to have 2:1 ratio of working frequency band, ring load [3] teeth horn together with the curved shape corrugate feeding structure are used. There are four parts in the horn structure. Part A is the match between the mode transformer with the circular waveguide, while part B is employed to transform the TE_{11} wave in waveguide into HE_{11} in the corrugated waveguide, part C is the transition part that have different height of teeth working for different frequencies, finally, part D is the radiation section for the far field patterns.

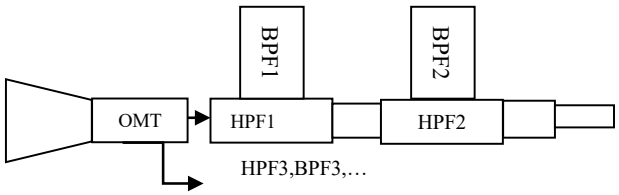

Fig. 1. Diagram of the horn and feeding system

III. DESIGN OF THE FINLINE OMT AND FILTERS

A new wideband OMT based on traditional finline OMT is proposed and designed. The new OMT is shown in Fig.2,A pair of diametrically opposite taped metallic fins are fitted inside the waveguide to transform gradually the dominant propagating waveguide mode into a finline mode. The V polarization wave (vertical to the metallic fins plane) pass through the finline structure, and the H polarization wave(parallel to the metallic fins plane) is extracted from the side waveguide through the narrow circular gap of the finline. Different from the traditional finline OMT, dovetail fins instead of rectangular septum is fixed at the end of the main waveguide of the OMT, these modifications are helpful for the suppression of the E2 mode. The square waveguide has dimension of 10.67mm in each side, the width of the septum is chosen as 2mm,the narrow slot width is 0.3mm,and the total length of the septum is 143.3mm.

Many passive waveguide components used for space and ground applications, inductive components are ideal for low-loss high-power applications, and are well suited for low-cost high-precision manufacturing. The 18.7GHz wave is extracted through the first BPF. The HPF1 filter is designed based on principle of impedance match between the two

neighboring waveguide working for the different frequency. The higher frequency waves (23.8GHz and 37GHz)pass through the first HPF1,while the 18.7GHz wave is blocked by it. Similarly, the HPF2,BPF2 can be optimized in the same method.

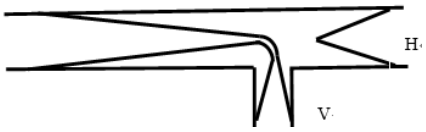

Fig. 2. The Finline OMT connecting with the waveguide.

IV. TEST RESULTS AND DISCUSSION

Near field system is used to measure the multifrequency dual polarizations corrugated horn and feeding system. The test results of the s parameters of this feed are displayed in Fig.3-5. It's clear the s11 at 37GHz working band is at the level of -18dB with the highest value of -15dB for the side channel, while the s11 is less than -20dB for the main channel within the 36.5GHz-37.5GHz band. It's obvious that the feed have symmetrical patterns at all three frequencies, that will be very helpful for the radiometer use. The highest crosspolarization are -23dB@18.7GHz.

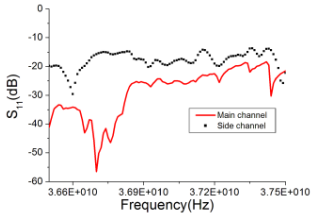

Fig. 3. S11 of the feed with OMT and filters at 37GHz band

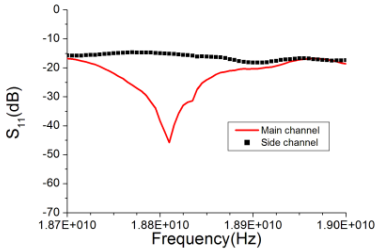

Fig. 4. S11 of the feed with OMT and filters at 18.7GHz band

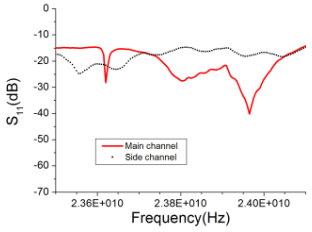

Fig. 5. S11 of the feed with OMT and filters at 23.8GHz band

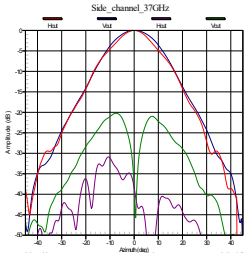

Fig. 6. Patterns of the feed at 37GHz frequency

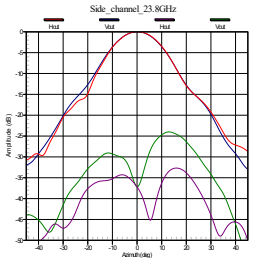

Fig. 7. Patterns of the feed at 23.8GHz frequency

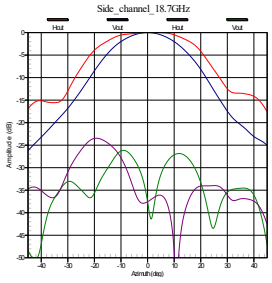

Fig. 8. Patterns of the feed at 18.7GHz frequency

V. CONCLUSION

Three frequency wideband finline OMT covering almost 2:1 frequency ratio with HPF and BPF to feed a profiled ring load corrugated horn has been presented. Test results show that the horn with OMT and filters has almost symmetrical main plain patterns, low cross polarization levels and low VSWR in all three working frequency bands at the all six ports. Considering the edge tapers are about -14dB, -16dB, -20dB (for different 3 bands) for the reflector, it is reasonable to believe that the whole dish antenna will have high beam efficiency which is very important for the radiometer use.

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